THE VALUE OF AN EGYPTIAN GIRL'S GOLD NECKLACE.

BY CHARLES S. ROBINSON.

IT seems to be customary now for tourists who visit Egypt, to get possession of a mummy, if possible, or a piece of one, or some sort of relic of one, in order to secure recognition as first-class orientalists. Just so, in Crusading time, pilgrims brought home branches from the Holy Land, and were delighted at being called "palmers" thereafter. But things are not always what they seem. A museum in the back parlor lacks the enthusiasm which is indispensable to the proper endurance of certain classes of oriental curios. There are many remains of ancient civilization that shine, and others that make one shudder; and travelers are not as discriminating in their purchases as they might be. It has mournfully to be admitted of Egyptian souvenirs that when they are good they are very good, and when they are bad they are horrid.

Two objects have come to the knowledge of the writer of this article which are more than worth having; they are worth more than the wealth of a thousand worlds like ours, provided one regards them as an investment of money, and makes his calculations at compound interest.

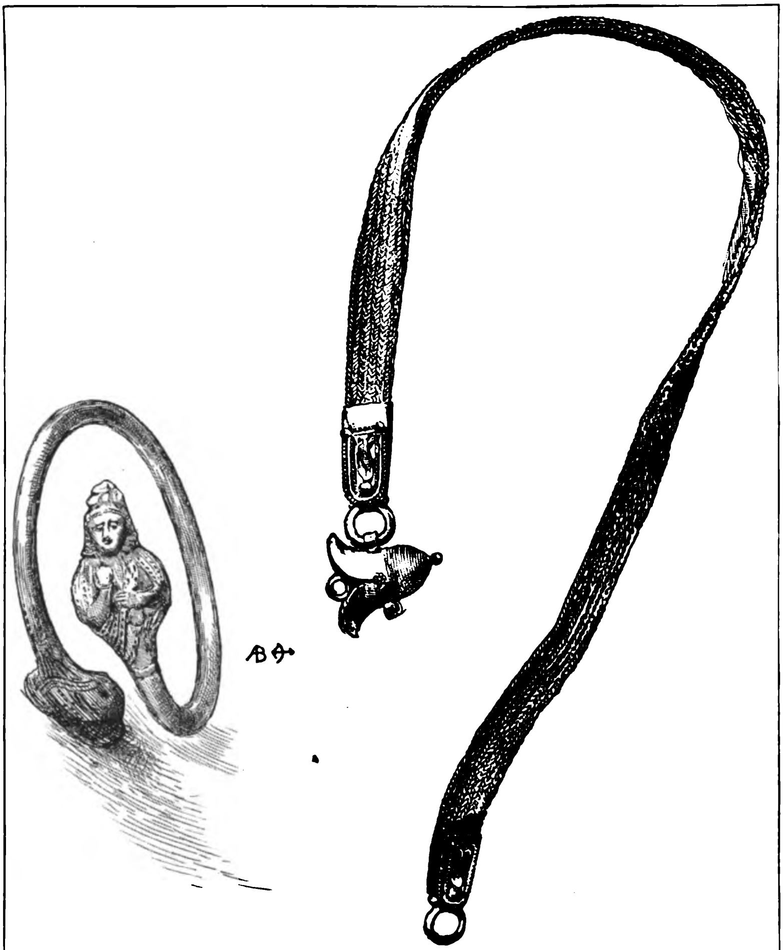
Of the one of them which met my eye first I do not care to speak very much at length; but it should be indicated and described. It has no inscription nor legend to help in its identification; but the wisest authorities declare that it belongs to the Ptolemaic age, or at all events to the Greek-Roman period which succeeded it. That gives a generous margin of about six hundred years just before and just after the birth of our Lord Jesus Christ, within the limits of which its history must be reckoned. It is a silver bracelet, about two and a half inches in diameter, solid and stiff, and put on like a modern bangle by an awkward stretching of its spiral to get one's hand through. It is unjoined, of course, at the ends, each of which is flattened out in a wide surface so as to be engraved with the figure of a stately deity in the form of a human bust crowned with emblems of supremacy. We may reckon this as nearly nineteen hundred years old, and so standing as a coeval representative of the whole Christian era. It is worth looking at for its own sake, even though we know nothing of its ancient owner. While the graver was cutting the lines upon it, it may possibly have been he could have heard the strain of the first Christmas carol by the angels, if only he had been in Palestine rather than in Egypt, and had chanced to be out on Bethlehem hills one night four years before "A. D." began.

The other object is of more interest still to all of us. It is a chain of exquisite gold, a rich orange yellow in color, with links dexterously twined one upon another. It is about thirteen inches long, three-eighths of an inch wide, and as nearly a tenth of an inch thick as I can measure it with a rule. The ends of it were at first fitted only with small solid rings set into clamps beautifully ornamented with leaf-work. Perhaps it was fastened to the wearer's neck by a filament or cord of silk tied through. The present owner has arranged a modern clasp in the shape of the lotus-flower. It can still be used, and indeed as well as ever, as an ornament for one in full dress. It is so flexible, falling down into picturesque folds the moment it is let go, that it seems more like a ribbon of delicate tissue than like mere metal. An expert goldsmith told me, after he had examined it with his glass, that it undoubtedly had a perfectness of uniformity in the links which could be found only in a chain manufactured by machinery.

This was to me a matter of wonder, for I was not prepared to learn that the ancient Egyptians had the knowledge of machines which could produce woven fabrics from pure gold. It was at once a discovery and a delight. It must be confessed that when I have spoken of this necklace as belonging to a princess I have had no actual authority. It dates from the age of Moses, if Herr Emile Brugsch is correct in his supposition (see letter, page 734) as to its belonging to the nineteenth dynasty,— a learned period, it is a fact, but how much acquaintance the nation had then with delicate machinery it is not easy to say. This ornament was found in one of that range of tombs opened along the Nile, where royal and priestly burials were frequent. It may have been worn by a daughter of a king, but not yet is any one able to give her name, her lineage, or her history.

These two acquisitions made in Cairo, two or three years ago, have been of themselves a peculiar help to me. They are accompanied by one of those letters giving careful and skillful authentication from Emile Brugsch, which he, as the director of the museum, is accustomed to bestow upon strangers who purchase; he never goes beyond what he can candidly aver, and so his testimonials are always of interest and real value.

It so happened that I was delivering a course of lectures on Egyptian history, as illustrated by the discoveries of some mummies now on exhibition in the museum at Bûlak, near Cairo; and I wished to make a vivid impression,— especially upon the minds of the younger people among my hearers,— which would convey to them the meaning of such a period of time as three thousand or four thousand years. I told them, in a familiar way, just before I began my lecture, how interesting this necklace had proved to me; and I promised to borrow it again and bring it for the next week's lecture. But I asked the boys and girls to make a calculation to show what a great, great while three thousand years of time must be.

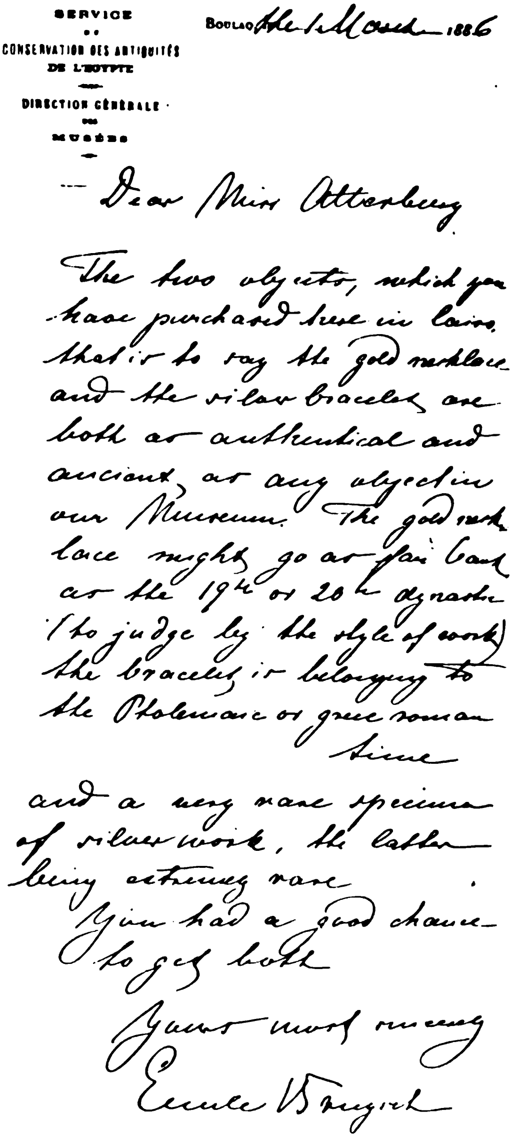


THE SILVER BRACELET. THE GOLD NECKLACE.

Years ago, when arithmetics less accurate than those now in use were put in the hands of scholars, it used to be given as a rule that money, at compound interest at six per cent. a year, would double itself once in every eleven years or a little more; now the rules say it requires twelve. To render the big problem a possibility for even the youngest mathematicians, we settled on thirty-six hundred years ago, as the time when the Egyptian girl wore her beautiful chain.

Then the question was this: How much would the money which bought the gold chain, if it had been American money, thus put at compound interest for thirty-six hundred years at six per cent., amount to to-day if the original price had been equal to twenty dollars? Then I gave the hint, so as to help a little in the outset with the smaller boys, that it could be answered by solid work in multiplying, of course; but that this would be very long and wearisome. It could also be answered according to the common rules of geometrical progression. And it could be answered, more easily yet, by the same rule expressed in a formula, made up of algebraic signs and letters. But the best way to reach the end quickly, would be to bear in mind that twelve would go into thirty-six hundred just three hundred times; so this sum of twenty dollars would have to be considered as doubling itself three hundred times. That is, the problem would be made perfectly clear, if only we could ascertain what would be the three hundredth power of two, and then multiply that vast sum by the twenty dollars which the necklace cost in the beginning.

The matter excited much enthusiasm in the public schools; but almost all found the enormous figures needed for the calculation too much for their patience. There was one plucky boy who toiled through with a wonderful courage. Seven days after that lecture was over, he sent me a letter saying that he had done his best and believed he had the correct result. It should be stated, however, that at first I had given out the number of thirty-three, instead of thirty-six, hundred years, for I had in mind the old rule which gave eleven years as the period in which a sum would double itself, instead of twelve. Hence my brave boy's answer was this: $65.476,163, 865,100,—and then add sixty-nine more ciphers! He said that he had dropped the decimal places in the last two or three multiplications, and this would change in some small measure the grand result. For, indeed, it was grand.



SERVICE
DE
CONSERVATION DES ANTIQUITÉS
DE L'EGYPTE
DIRECTION GÉNÉRALE
DES
MUSÉES

BOULAQ the 1st March 1886

Dear Miss Atterbury

The two objects, which you
have purchased here in Cairo,
that is to say the gold necklace
and the silver bracelet are
both as authentical and
ancient, as any object in
our Museum. The gold neck-
lace might go as far back
as the 19th or 20th dynasty
(to judge by the style of work)
the bracelet is belonging to
the Ptolemaic or greec roman
time
and a very rare specimen
of silver work, the latter
being extremely rare.
You had a good chance
to get both

Yours most sincerely
Emile Brugsch

FAC-SIMILE OF LETTER FROM HERR EMILE BRUGSCH.

It is not necessary for me to pronounce whether this answer is a true one: I have never been carefully over the figures. Life is short, and I can prolong my usefulness, I am persuaded, by prudently avoiding such mathematical problems as this lad undertook to solve by a reckless exertion of main strength in simple multiplication. So I beg leave to admit that his answer satisfies all needs of investment which I expect ever to contemplate with necklaces or anything else. But if I ever need a patient, faithful, hard-working boy, to trust, I think possibly I know where to find him, and I shall remember his name.

Then maturer mathematicians took up the problem. Earliest among them was "a schoolma'am." I saw her afterwards, with her fair hair in plain parting upon her broad forehead; and now I have one more good friend. She was unfortunate in catching the exact sums mentioned upon the platform, and so took three thousand *two* hundred, instead of three hundred. But (as she wrote) "it made but little difference." The ingenuity was perfectly legitimate in her process of calculation, and so she saved an enormous amount of work by raising 106, that is, $1.06, to the fortieth power, and multiplying that by itself; thus she reached the eightieth power, and by multiplying that by the twentieth power she gained the hundredth. After that, she multiplied the hundredth by the hundredth, and so got the two hundredth. Then the advances pushed on rapidly; the two hundredth power was multiplied by the two hundredth in turn, and the resulting four hundredth, by the four hundredth, and then the eight hundredth by the eight hundredth, gave the sixteen hundredth, which, multiplied by itself, brought the thirty-second hundredth power.

A single multiplication more did the work; and I think it was an industrious achievement of climbing mathematical stairs, that might become as famous as Xenophon's retreat of the ten thousand, or Sherman's march through Georgia to the sea, if only it had the proper poet to sing its praises. The result was this: $6,462,434.595,555,262,158, 761, 846,458,349, 521,917, 919,009, 818, 238, 064, 906, 501, 568, 467, 523, 393, 211, 837, 120, 242, 444, 906,380.08. It may be said that one of the highest authorities in the land has pronounced this enormous result to be practically correct.

By this time, the popular enthusiasm was kindled to a blaze. People tried to numerate these ninety figures, so as to tell each other how much the twenty dollars invested in a necklace would be worth if invested for thirty-three hundred years at compound interest; and nobody could read out the sum. Experts took up the problem; one was a soldier trained in the use of logarithms and such things as they work with up at West Point. The problem was rather simple, when one had tables and knew how to treat them. This "lightning-calculator" wrote a calm letter which showed that he knew what he was talking about. He said that the only way of solving the problem with absolute correctness, was to compute the interest by ordinary methods thirty-three hundred times, carrying all the decimals, however many, as they could not safely be disregarded in an operation so extensive and of such magnitude. He added that the approximate solution might be obtained with ease by means of logarithms; but, it would have to be confessed that logarithms were only approximations to the truth. Then he defined his position by remarking that in ordinary logarithmic operations six decimal places are used. In others, where a larger number would be involved, or a greater accuracy desired, twelve decimals are employed; and in extensive problems in surveying or star-measuring, a much larger increase would have to be used. He pronounced this particular problem one which transcended inconceivably any of the historic calculations thus far attempted, and insisted that any accurate working of it by means of logarithms must be far from the absolute truth, and that only the first few figures could really be vouched for.

Taking twelve places of decimals, therefore, he offered his solution, which he hoped would prove as correct as could be obtained with customary means. So he resolved his question into a geometrical progression in which n, the number of terms, is 3,301; a, as the first term, would be 20; r, the constant ratio, would be 1.06; and l, the last term, must be the answer required.

The formula for working would be given in words thus: the last term equals the first term multiplied by the ratio raised to the power indicated by the number of terms less one. Then he works out the problem.

The logarithm of r is .025305865265. Multiplying this by 3,300, or $n-1$, we have 83.509355374500. Multiply by 20, or add the logarithm of a, that is, 20; so we get 84.810385370164, the logarithm of l.

This last is the logarithm of the required answer, and indicates that the result contains 85 integral figures. The number that answers to this in the tables is: $6,462,274,246,268,656,716,417,910,447, 761, 044, 776, 104, 477, 610, 447, 761, 044, 776, 104, 477,810,447,761,044,776,104,477.61. This would be the value of the gold.

Alluding to the proposition itself, he remarks that the old calculation was faulty, in that, as a matter of fact, a sum of money would not double itself in eleven years at compound interest at six per cent. It would require nearer twelve than eleven: the amount of $20 for eleven years would be only $37.97; but for twelve years would be $40.25. A difference would be made between the two results if the problem should be worked out on the other basis; indeed, the result would be nearly a hundred and sixty thousand times too great. But he observes with a calm quaintness peculiarly mathematical, "That would not matter much."

For now we reach the great mystery and wonderment of this calculation: the result of it is simply bewildering. I am willing to admit that it has seemed to me so incomprehensible that I have sent the general problem around to some of the best men in the country. My friend whose explanation gave so much help proposed a curious illustration of the result he had reached. To show how inconceivably enormous is this sum of money, let it be assumed that ten silver dollars, piled upon one another, are one inch in height. Six hundred and thirty-three thousand six hundred dollars thus placed would extend a mile. Assume the whole distance from the earth to the sun to be 95,000,000 miles. The number of silver coins thus piled, necessary to bridge the firmament, between sun and earth, would be 60,192,000,000,000. Suppose the number of dollars shown in the answer we got to the problem, should be put into columns, going up to the sun and back. The number of those columns nobody could read aloud; we do not know how to numerate such strings of integers. The number of times the dollars would go to the sun would claim seventy-one places of figures to state them. A rough calculation which anybody can make will show that this amount of silver, cast into a solid mass, would be bigger than the sun and entire solar system if combined. What mind can conceive this?

Since I began to use this chain as an illustration, I have heard from another eminent teacher whose position on the staff of the Albany Academy is proof of his scholarship. I raised the conditions of the problem, lately, and am now accustomed to mention the time as 3600 years; and it is better to say twelve years than eleven for the period of doubling at compound interest; all this is to make round numbers. It has brought me a large number of estimates in illustration. The mathematical professor at Albany worked out the problem, and I have his result. He requires ninety-two places of figures to state it. In exact detail it is this: $12,625,000,000,000,000,000,000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000, 000; 000, 000, 000, 000, 000, 000. Then this is to be multiplied also by twenty, because it was twenty dollars which was put at interest, and the result represents the actual value of the necklace. A likelier actual present value for this necklace, however, would be about a hundred dollars! Then he follows with some very suggestive comments and illustrations.

Practically, the above sum is infinity. The interest upon it for one year would be practically infinite. The fact that those ninety-two places are virtually, and to all intents and purposes, infinity, may become more evident by considering that, if the amount originally put at interest had been one cent instead of one dollar, the result would only be lessened by two places of figures,—that is, one one-hundredth; so if one mill were originally the principal, the result would be lessened by three places of figures; or, in other words, would be one one-thousandth. The mind can not conceive of any such numbers; it can not appreciate any such differences in the results; the figures throw all astronomical ones into the shade—even such as are used in reckoning with the remotest stars. If we take the velocity of light, and then say it will need four years to travel from a distant constellation, the whole distance so ascertained is little compared with a result measured by a line of ninety-two figures. All the wealth of the world, real and personal, would not approach such a number of dollars; a million of worlds would not approach it! What is a man to do with such revelations?

And then, in order to calm my perturbed mind and clear my bewildered brain, I sent the entire calculations and comments and illustrations to my honored friend, Professor Newton of Yale University. This patient man was good enough to examine them, and he says they are correct, in the main, in all their particulars. And he puts some interesting questions of his own, that are excellent to close this article with.

He bids me ask "my arithmeticians" to compute the size of a pile of diamonds worth one million dollars to the cubic inch, which pile, as a mass, should be worth the difference between the twenty dollars, put out at interest at six per cent. compounded annually, and the same put out to be compounded semi-annually, for thirty-six hundred years. He grows bold enough to say that this difference, when the interest is at three per cent. for six months, is several times as great as the vast amount we have been already contemplating. So now, having set me to gazing awhile at such a pile of diamonds, he proposes that I ask some one just to compute how many such spheres of diamonds it will take to reach a star, provided it is a million times as far away as the sun. And then he adds: "Of course this is all play with numbers, but it interests."

THE RAIN-HARP.

By Frank Dempster Sherman.

When out-of-doors is full of rain,
I look out through the window-pane,
And see the branches of the trees,
Like people dancing to the breeze.

They bow politely, cross, and meet,
Salute their partners and retreat,
And never stop to rest until
They reach the end of the quadrille.

I listen, and I hear the sound
Of music floating all around,
And fancy 't is the Breeze who plays
Upon his harp on stormy days.

The strings are made of rain, and when
The branches wish to dance again,
They whisper to the Breeze, and he
Begins another melody.

I 've heard him play the pretty things
Upon those slender, shining strings;
And when he 's done—he 's very sharp,—
He always hides away the harp.